

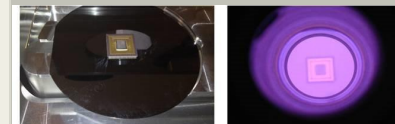
Hydrogenation of Very Long Wavelength Infrared Focal Plane Arrays Based on Type II Superlattices, Phase I

Completed Technology Project (2016 - 2016)



Project Introduction

We propose to advance the Ga-free InAs/InAsSb type II superlattice (T2SL) materials technology for very long wavelength infrared (VLWIR) focal plane arrays (FPAs) by passivating lifetime-limiting defects with hydrogen from inductively coupled plasma (ICP) H₂-plasmas. In Phase II, 1k x 1k detector arrays will be fabricated and hybridized to matching read-out integrated circuits for implementation in future Earth and Planetary science infrared imaging instruments and become part of future space missions. Larger format FPAs (2k x 2k) will be realized as part of follow-up developments extending beyond Phase II. In Phase I, we will compute and optimize the electronic band structures, optical properties, Auger coefficients and ideal diffusion-limited dark currents of InAs/InAsSb T2SL absorber materials. The operating temperatures and overall thickness will be used as part of a trade-off study designed to achieve the quantum efficiency and dark current program goals. Shockley-Read-Hall minority carrier lifetimes of T2SLs are predicted to increase due to hydrogen-passivation, leading to larger signal-to-noise ratios for improved range of detection, enhanced discrimination capabilities, or operation at higher temperatures. Reducing the electrical activity of defects by passivating them with hydrogen is equivalent to lowering their density, and has proven successful in other semiconductor systems. The proposed hydrogenation technique makes use of the same dry-etch equipment employed during FPA manufacturing, making it easy to implement. In addition to the potential to remove the deleterious effects of bulk material defects, ICP hydrogenation also improves the detector's surface passivation quality. Smaller pixels, reduced integration times, and systems with larger fields-of-view will be realized, allowing the imaging of fast changing scenes over long ranges.



Images of an LWIR 320x256 FPA being loaded into Sivananthan Laboratories' Aviza r4-ICP system (left), and exposed to hydrogen plasma (right)

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Table of Contents

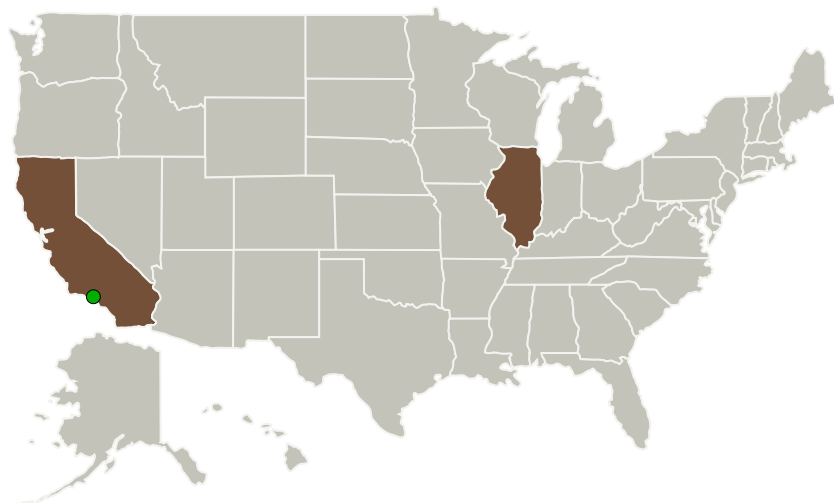
Project Introduction	1
Primary U.S. Work Locations and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Images	3
Technology Areas	3
Target Destinations	3

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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Sivananthan Laboratories, Inc.	Lead Organization	Industry Minority-Owned Business	Bolingbrook, Illinois
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations

California	Illinois
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Project Transitions

▶ **June 2016:** Project Start

✓ **December 2016:** Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/139607>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Sivananthan Laboratories, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

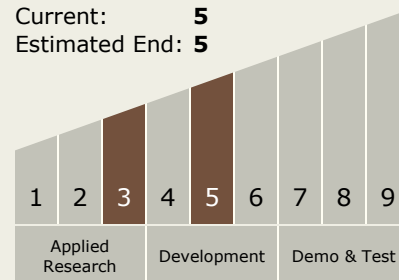
Carlos Torrez

Principal Investigator:

Paul Boieriu

Technology Maturity (TRL)

Start: 3
Current: 5
Estimated End: 5



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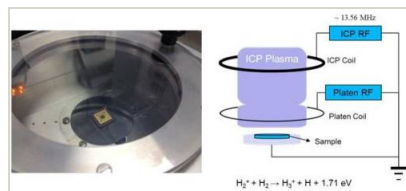
Images



Images of an LWIR 320x256 FPA being loaded into Sivananthan Laboratories' Aviza r4-ICP system (left), and exposed to hydrogen plasma (right)

Briefing Chart Image

Hydrogenation of Very Long Wavelength Infrared Focal Plane Arrays Based on Type II Superlattices, Phase I
(<https://techport.nasa.gov/image/133580>)



Final Summary Chart Image

Hydrogenation of Very Long Wavelength Infrared Focal Plane Arrays Based on Type II Superlattices, Phase I Project Image
(<https://techport.nasa.gov/image/133576>)

Technology Areas

Primary:

- TX08 Sensors and Instruments
 - └ TX08.1 Remote Sensing Instruments/Sensors
 - └ TX08.1.1 Detectors and Focal Planes

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System